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RELATIONSHIP BETWEEN BMD, APPARENT AND ASH DENSITY OF HUMAN TRABECULAR BONE

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Abstract

Trabecular bone is one of components of bone which quality is responsible for strength whole human bone. It is a porous structure, which change with age. In medical practise for estimation quality of bone the most often is used dual energy x-ray absorptiometry (DEXA). For scientific investigation of bones are often used apparent density and ash density. In the work presented results comparison values BMD, apparent and ash density obtained from measurement samples of human trabecular bone. Obtained values coefficient of determination R^2 for relationship between this densities were in range 0,28÷0,62.

Keywords: *trabecular bone, BMD, apparent density, ash density*

1. Introduction

Trabecular bone is one of components of bone which quality is responsible for strength whole human bones. It is a porous structure, which change with age. In medical practise for estimate quality trabecular bone most often is used dual energy x-ray absorptiometry (DEXA) [1-3]. Result of the measurement is value of BMD density selected part of bone. In scientific investigation trabecular bone mostly is used apparent density App.D [4,5] or ash density Ash.D [6,7].

The aim of the work is to determine relationship between BMD, apparent and ash density for human trabecular bone.

2. Materials and methods

Material to the investigation were 42 samples of human trabecular bone. Samples were collected from 21 osteoporotic and 21 coxarthrotic femoral heads gained in result of hip arthroplasty. The samples used to investigation have cylindrical shape about diameter 10 and height 8,5 mm. Manner of collecting sample is presented in fig. 1 [8].

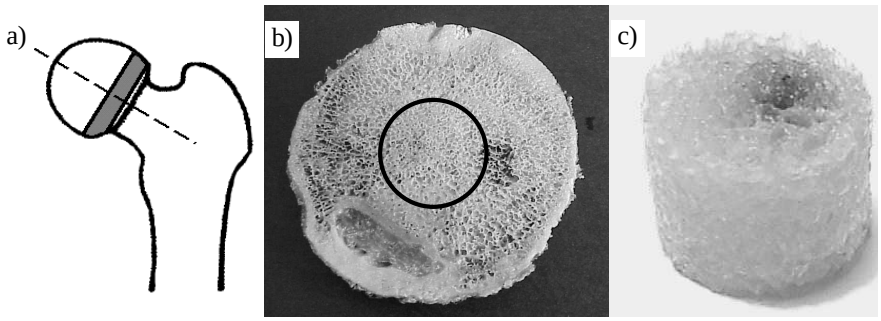

Fig. 1. Manner of collecting sample: cutting slice a), cutting sample b), sample c)[8]

The age of the patients ranged from 50 to 91 with an average of 73 years. The samples were stored in 10% formalin solution at the room temperature.

BMD density was performed with scanner Lunar Expert, General Electric Company. Apparent density obtained by dividing mass of sample by its volume. In the aim obtain ash density samples were burning in temperature 500^{o}C by 15 hours [9]. Ash density Ash.D was calculated by dividing mass burned sample by its volume before burning.

3. Results

In Tab. 1-2 presented minimal, maximal and mean values, standard deviation and relative standard deviation for BMD, apparent and ash density for coxarthrotic and osteoporotic samples respectively. For both investigated group values RSD are on the similar level only for BMD. For App.D and Ash.D differences are 8% and 13% respectively.

Tab. 1. Values of densities for coxarthrotic samples

	min	**max**	**mean**	**SD**	**RSD**
BMD, g/cm^2	0.135	0.396	0.285	0.077	27 %
App.D, g/cm^3	0.504	1.148	0.919	0.162	18 %
Ash.D, g/cm^3	0.174	0.512	0.341	0.089	26 %

Tab. 2. Values of densities for osteoporotic samples

	min	**max**	**mean**	**SD**	**RSD**
BMD, g/cm^2	0.134	0.343	0.209	0.055	26 %
App.D, g/cm^3	0.734	1.120	0.910	0.090	10 %
Ash.D, g/cm^3	0.113	0.592	0.251	0.097	39 %

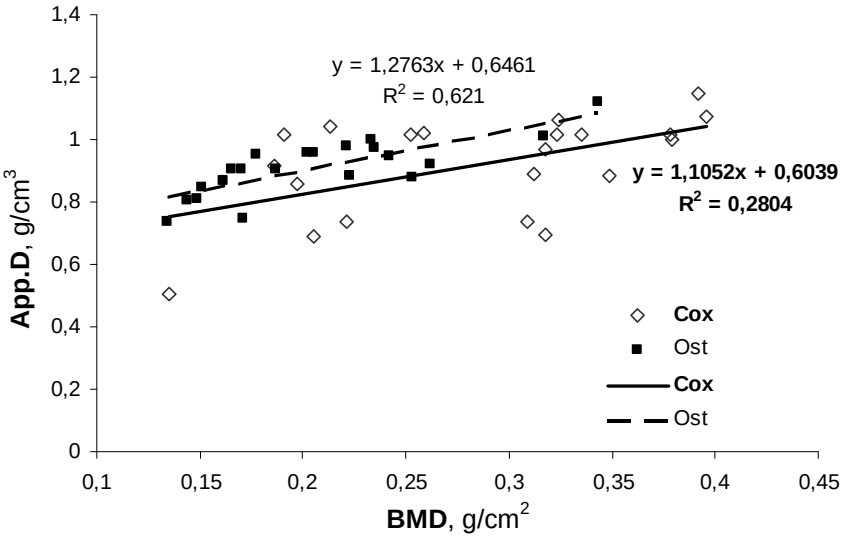

Fig. 2. Relationship between BMD and apparent density

In Fig. 2–4 presented relationship between BMD–App.D (Fig. 2), BMD–Ash.D (Fig. 3) and Ash.D–App.D (Fig. 4). For osteoporotic samples the relationships between the densities are similar R^2=0,53÷0,62. For coxarthrotic samples relationship BMD–App.D and Ash.D–App.D are clearly weakly R^2=0,28÷0,29. For relationship BMD–Ash.D coefficient of correlation R^2=0,52.

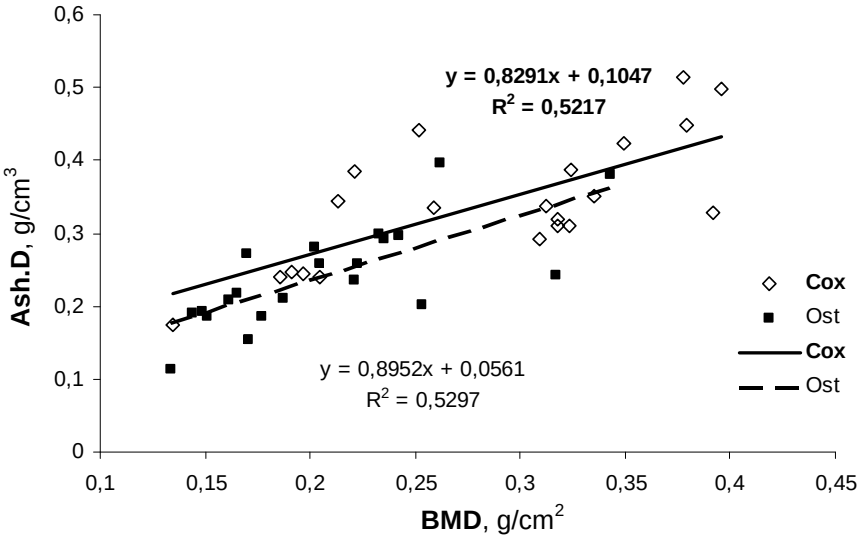

Fig. 3. Relationship between BMD and ash density

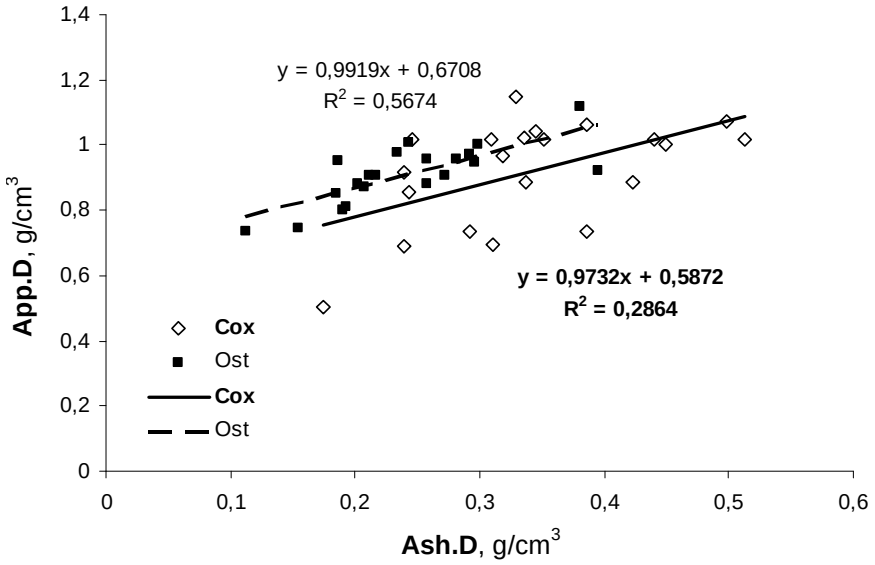

Fig. 4. Relationship between ash and apparent density

4. Conclusions

Analysis results densities measurement for both group of samples are visible significant differences in mean values for BMD and Ash.D. For this indices higher values were obtained for coxarthtrotic samples. For App.D mean value is similar in both groups.

Obtained values of coefficient of determination only for relationship BMD-Ash.D are similar in both groups and contain in range R^2=0,52÷0,53. For relationships BMD-App.D and Ash.D-App.D values R^2 are higher in osteoporotic group (R^2=0,62 and R^2=0,57). The same relationship in coxarthrotic group were R^2=0,28 and R^2=0,29.

Measurement BMD and Ash.D are based on measurement mineral of phase of bone. App.D was calculated by dividing mass of sample by its volume. Trabecular bone is porous structure, therefore mass include marrow, blood or formalin (samples were stored in formalin) in pores of sample. It would be reason of errors in estimating the parameter. In result relationships App.D with BMD and Ash.D values wouldn't give satisfying values R^2. Lower values R^2 in coxarthrotic group for relationship BMD-App.D and Ash.D-App.D probably are caused character of coxarthrotic disease. One of results the disease is hypertrophy articular cartilliage in pores of trabecular bone. It would be influence on result measurement apparent density in this group of samples.

Acknowledgements

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